PRECISION DC VOLTMETER

MODEL DC-100ARLN

SERIAL #_____

CALIBRATION STANDARDS CORPORATION
ALHAMBRA, CALIFORNIA

CUmberland 3-8156

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IMPORTANT

FOR OPTIMUM RESULTS READ THIS INSTRUCTION MANUAL CAREFULLY

The instrument covered in this manual is of an advanced design in the field of transistorized precision test equipment.

You will find this instrument has many distinct advantages over the operating characteristics found in equipment costing many times as much.

Since this instrument incorporates advanced engineering techniques and design, it is imperative that you become familiar with the proper operating procedure.

One of the superior features found in this instrument is the elimination of the usual electronic zero controls. The meter need only be zeroed by the mechanical adjustment screw on its case while the instrument is in operation.

The meter zeroed in this manner, may show an offset of the needle from zero when the instrument is turned off. This is normal. (The mechanical zero of the meter deviates slightly from the instrument's electrical zero.)

PRECISION DC VOLTMETER

DC-100ARLN

1. The line cord should be plugged into 117 volts 60 cycle power.

2. Turn null selector to the V.T.V.M. position and let unit warm up for about ten minutes.

3. After warm up, zero meter by the mechanical zero adjustment.

4. Turn the range selector to the desired range and connect the voltage to be measured to the terminal posts. Either the positive or negative terminal may be grounded to the common terminal or the input may be left floating.

5. When the voltage is applied, the V.T.V.M. will measure it to an accuracy of ±4%. If the needle goes to the left and it is desired to measure the voltage using the differential mode of the instrument, then place the polarity switch in the negative position. If the needle goes to the right and it is desired to measure the voltage using the differential mode of the instrument, then place the polarity switch in the positive position.

6. Set the first two readout dials to this approximate reading and advance the null selector to the 1 volt position. Continue to adjust the rest of the readout while increasing the null sensitivity.

7. When the null selector is at full sensitivity (1MV) and the meter is reading zero, read the voltage from the Kelvin Varley dials to an accuracy of better than ±.05% + 5 microvolts absolute. You may not get a reading of zero if the voltage you are measuring is fluctuating.

PRECISION DC VOLTMETER

DC-1000A/B

1. The line cord should be plugged into 117 volts AC only.

2. Turn null selector to the V.C.V.M. position and let unit warm up for about ten minutes.

3. After warm up, zero meter by the mechanical zero adjustment.

4. Turn the range selector to the desired range and connect the voltage to be measured to the terminal posts. Either the positive or negative terminal may be grounded to the common terminal or the input may be left floating.

5. When the voltage is applied, the V.C.V.M. will measure it to an accuracy of ±4%. If the needle goes to the left and it is desired to measure the voltage using the differential mode of the instrument, then place the polarity switch to the negative position. If the needle goes to the right and it is desired to measure the voltage using the differential mode of the instrument, then place the polarity switch to the positive position.

6. Set the first two readout dials to their approximate reading and advance the null selector to the 1 volt position. Continue to adjust the readout of the readout while increasing the null sensitivity.

7. When the null selector is at full sensitivity (1 mV) and the meter is reading zero, read the voltage from the four-dial display to an accuracy of better than ± 0.05% + 0.5 microvolts absolute. You may not get a reading of zero if the voltage you are measuring is fluctuating.

READING EXCURSIONS ABOUT A NOMINAL VOLTAGE

8. To read excursions of voltage about a nominal value, set the readout dials to the nominal value and observe the excursions directly on the meter on any of the four null ranges. A right hand deflection of the meter indicates the voltage has increased above the nominal value by the amount indicated on the meter. For voltages read on the 10 volt range and below, use null sensitivity as marked. On the 100 volt ranges, the value must be multiplied by a factor of 10 and the 1000 volt range, multiply by a factor of 100.

MEASUREMENTS BELOW 1 VOLT IN DIFFERENTIAL MODE

9. When making measurements below 1 volt, turn Range Selector Switch to the .1 volt position; set Null Selector to the 1 mv position; set all readout dials to zero and short positive and negative input terminals together.

10. Now set the mechanical meter adjustment to zero. This will cancel out error due to zero offset between the 1 millivolt range and the V.T.V.M. range.

CIRCUIT DESCRIPTION

Precision Voltmeter Model DC-100ARLN is completely transistorized and designed for long, trouble free life. There are no batteries or other parts that would normally need replacing, except the electro-mechanical chopper.

The voltmeter operates on the principle of comparing an unknown voltage with an adjustable known voltage. A sensitive null detector is used to detect when the voltages are equal.

The voltmeter is composed of three (3) basic elements:

(1) Ultra Stable Reference Supply.

(2) Accurate Kelvin Varley Divider.

(3) Sensitive null detector.

1. The heart of the voltmeter is the ultra stable reference supply. This supply is a dual regulated transistor supply powering a compensated Zener reference string. The regulation for a line change of 100 volts to 130 volts is better than ±.005%. The temperature co-efficient of the reference supply is better than .0005%/^{o} C. over a temperature range of 10^{o} C to 40^{o} C. The supply is usable above 40^{o} C. with a slight derating of TC and line voltage regulation.

   Long term stability of the reference supply is better than ±.005%/year. This reference supply is constructed as a plug-in module and can be supplied complete from the factory for ease of servicing.

2. The second basic element is the very accurate Kelvin Varley Divider. The first two decks are composed of 11 precision wire wound resistors per deck.

   The first deck has resistors matched to ±.0025% and the second deck has resistors matched to ±.005%. The last three readouts are accomplished with a selected precision 10 turn potentiometer.

   The linearity of this potentiometer is better than ±.05%. The two decks and the 10 turn potentiometer are matched together to produce an overall divider accuracy of better than ±.01% absolute.

   The range selector preceeds the Kelvin Varley Divider. Each range has a fine adjustment potentiometer for calibration and is calibrated separately except that the 10 volt range must be calibrated first.

3. The third element is a very sensitive and stable calibrated null detector. This null detector is used to indicate the difference between the unknown external voltage and known internal voltage.

   At maximum sensitivity the null detector has a full scale deflection of 1 mv. This is ample sensitivity for accurate low level voltage measurements. The V.T.V.M. accuracy is ±4% of full scale over a temperature range of 20° C. to 30° C. The instrument is usable to 40° C. but some derating should be considered.

   It is not recommended that the instrument be operated above 45° C.

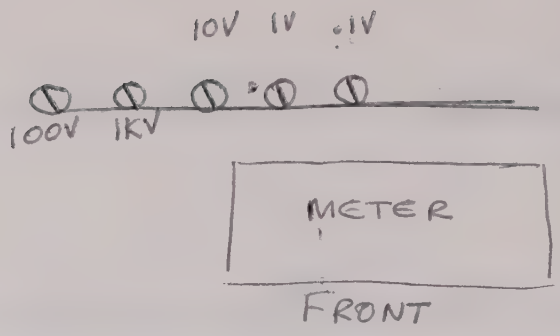
The null detector is capable of a long trouble free life except for the occasional replacement of the chopper. This is a James C-1800 chopper. Choppers are in stock at the factory.

Occasional calibration of the null detector may be made by adjusting the gain adjustment potentiometer at the top of the plug-in amplifier module.

The null detector is capable of large overloads without damage. On the 1 mv range a safe overload would be 50 volts short term and 10 volts long term. On the 10 mv, 100 mv and 1V positions, a safe overload of 500 volts is possible.

On the V.T.V.M. ranges, safe overloads are as follows:

.1	volt range:	20	volts
1	volt range:	70	volts
10	volt range:	250	volts
100	volt range:	700	volts
1000	volt range:	1500	volts


10V
1V
.1V
100V
1KV
METER
FRONT

CALIBRATION OF DC-100ARLN

A diagram in this manual shows the location of the calibration potentiometer and a setup for calibrating the voltmeter. The calibrator used in this calibration is designed and built by CALIBRATION STANDARDS CORPORATION. The resistors used in the divider are accurate to .002%. The calibrator has a built in null detector and 100 volt regulated power supply. A Calibrated Standard Cell or Zener reference must be supplied. Price of the calibrator will be given upon request. If the CALIBRATION STANDARDS CORPORATION calibrator is not used, instrument of .01% accuracy or better should be used to calibrate the precision voltmeter.

Calibrate the 10 volt range first by adjusting the 10 volt calibration trim potentiometer when the voltmeter is reading 10 volts with an exact 10 volts applied. Next repeat the same procedure on the 1 volt range using the 1 volt calibration pot. Repeat procedure on .1 volt range. On these ranges the meter has an infinite input resistance at null.

Now set the range switch to 100 volts and apply 100 volts to the meter (2 Meg. input resistance). Adjust the 100 volt calibration pot. This same procedure may be done on the 1000 volt range by applying 1000 volts and adjusting the 1000 volt calibration pot. In the case of the C.S.C. set-up, the 1000 volt range is calibrated with 100 volts by setting the K.V.D. dial to 100 volts on the 1000 volt range. In order to calibrate the meter this way you must accurately measure the linearity of the divider and make corrections. Even if this correction is not made, a possible error of about .01% may result on the 1000 volt range only.

(Calibration of DC-100ARLN Cont'd.)

This completes the calibration of the differential section of the voltmeter.

To calibrate the V.T.V.M. ranges, set the range selector to the 10 volt position and apply 10 volts. Adjust the potentiometer at the top of the amplifier plug-in module for full scale deflection.

MEASUREMENTS ABOVE 10 VOLTS WHEN READINGS ARE TAKEN FROM PANEL METER

When making measurements where readings are taken directly from the panel meter and on the 10 volt range and below, use full scale values as marked on the front panel.

On the 100 volt range, multiply the reading by a factor of 10. On the 1000 volt range, multiply the reading by a factor of 100. Due to the circuit design on the 100 volt range, the null detector will have reduced gain on the 1 mv and 10 mv position. This is due to a high internal source impedance of the high voltage input divider.

The gain is about 50% less in the 1 mv null position and about 15% less on the 10 mv position. Only a very slight loss of gain is noticed on the other null ranges. When the range selector is in the 1000 volt position a 10% loss of gain will be noticed in the 1 mv position. The other null ranges will have only a very slight loss of gain.

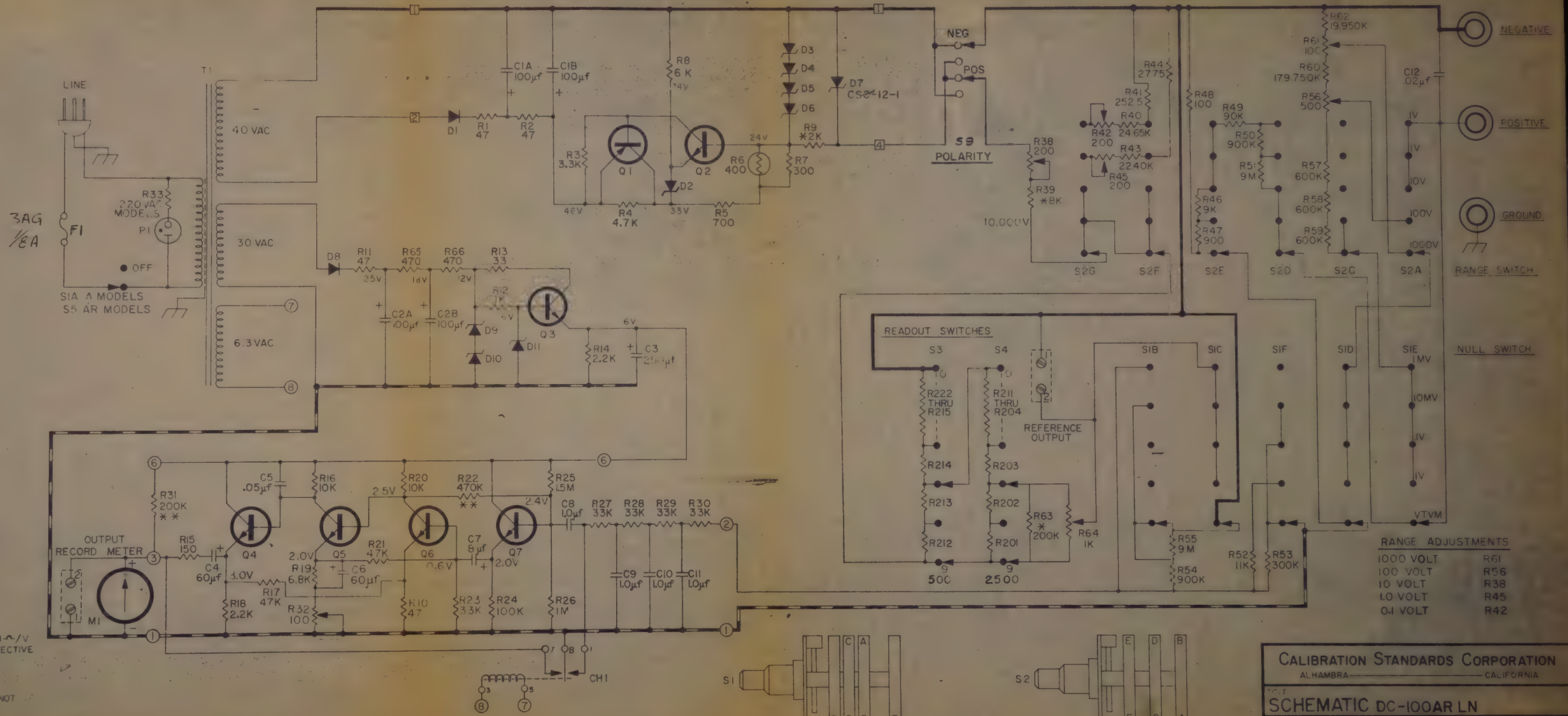
WARRANTY

The CALIBRATION STANDARDS CORPORATION warrants each instrument to be free from defects in material and workmanship. Material not covered by this warranty are fuses, choppers and tubes. The instrument must be returned to the factory with shipping prepaid and a complete report of the difficulty. This warranty is good for one year from the shipping date.

SHIPPING DAMAGE

If there is any damage to the instrument upon receipt, report this to the transportation Claim Agent immediately.

REVISIONS				
SYM	DESCRIPTION	E.S.	DATE	APPD



6. VOLTAGES **MEASURED** WITH 20,000 Ω/V METER RELATIVE TO THEIR RESPECTIVE GROUNDS.
5. (X) CONNECTIONS, REFERENCE MODULE.
4. (X) CONNECTIONS, AMPLIFIER MODULE.
3. ** APPROX. VALUE, SELECTED IN TEST, NOT USED IN ALL INSTRUMENTS.
2. * APPROX. VALUE, SELECTED IN TEST.
1. ALL RESISTORS ARE IN OHMS.

NOTES UNLESS OTHERWISE SPECIFIED

CALIBRATION STANDARDS CORPORATION
ALHAMBRA — CALIFORNIA

TITLE
SCHEMATIC DC-100AR LN

DRAWN	DATE	DRAWING NO.	ISSUE
C.A. BIBB	5 JAN 1963	340-160	
CHECKED Eock	APPROVED Eock		

DWG NO 340-120 | ISSUE C

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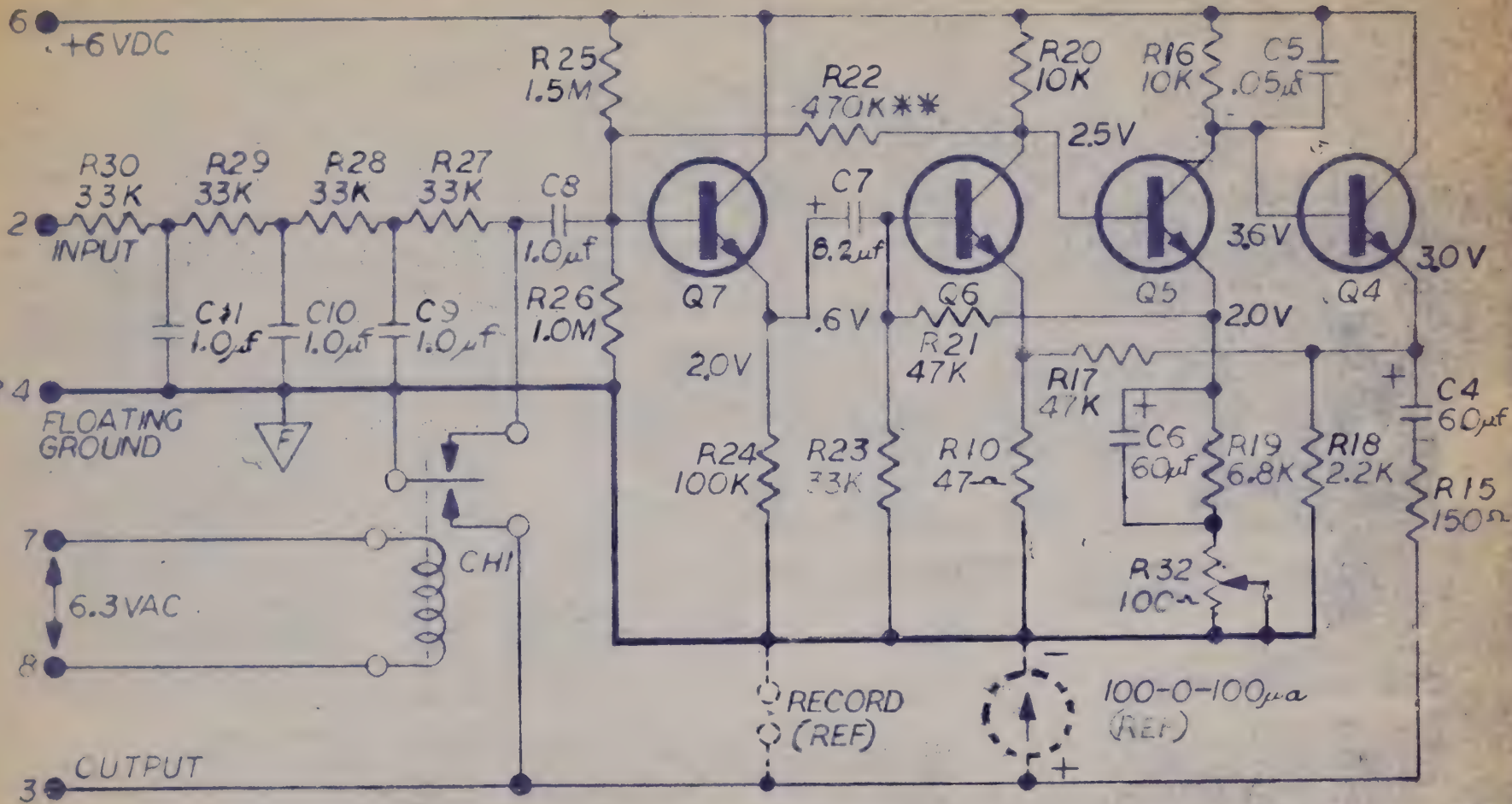
CHANGE	DATE	ISSUE	BY	APP
REVISED & REDRAWN	5-17-63	A	J.G.	
REMOVED CHOPPER NUMBERS	12-2-63	B	CAB	
8.2 WAS 8, DELETED 3V ON C6	12-11-63	C	RICK	CAB



** NOT USED IN ALL INSTRUMENTS, SELECTED

ALL TRANSISTORS ARE 215-015 *

TOLERANCES EXCEPT AS SHOWN
FRACTION ±
DECIMAL ±
ANGLES ±

DATE 5-17-63
DWN CRFCH
CHECK
APP
SCALE NONE

CALIBRATION STANDARDS CORPORATION
POMONA — CALIFORNIA

TITLE SCHEMATIC, AMPLIFIER, SILICON

NEXT ASSEMBLY
USED ON

DRAWING NO 340-120 | ISSUE C

DWG. NO. 340-018 | ISSUE F

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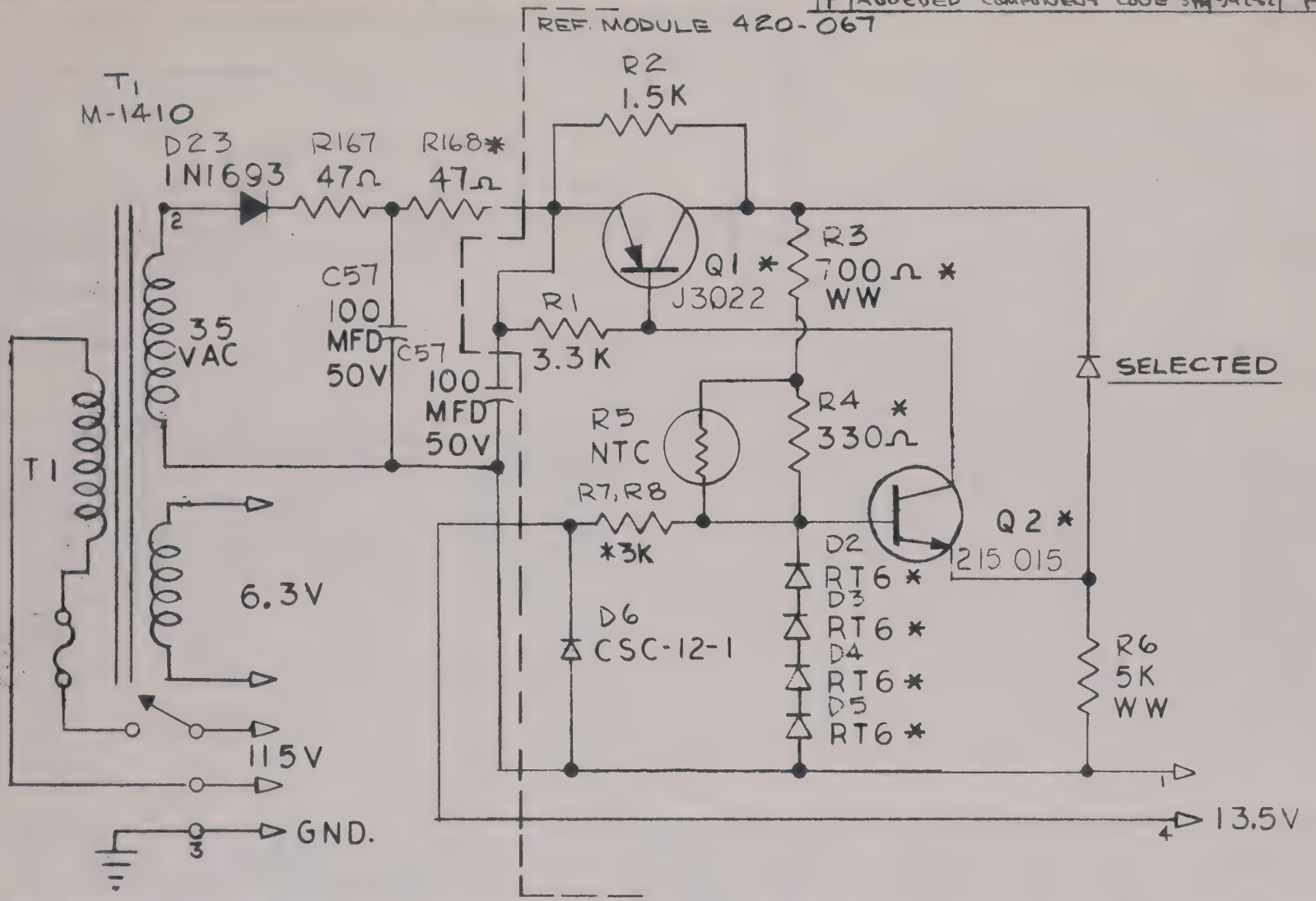
	CHANGE	DATE	ISSUE	BY	APP.
A	REVISED & REDRAWN	5.2.61	A	WJF	
F	ADDEDED COMPONENT CODE SYM	9-27-62	F	WJF	WJF



* FACTORY SELECTED

MATERIAL	QTY.

TOLERANCES EXCEPT AS SHOWN:
FRACTION ±
DECIMAL ±
ANGLES ±

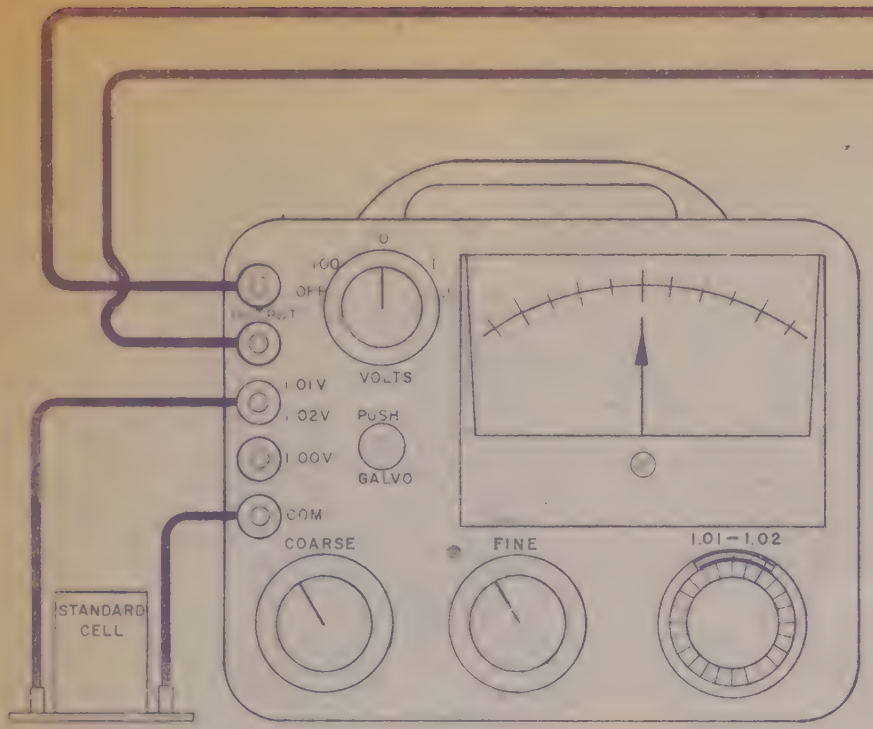
DATE: 12-7-60
DWN: WJF
CHKD:
APPD:
SCALE:

CALIBRATION STANDARDS CORPORATION
ALHAMBRA — CALIFORNIA

TITLE: 13.5 V REF. SUPPLY, SCHEMATIC

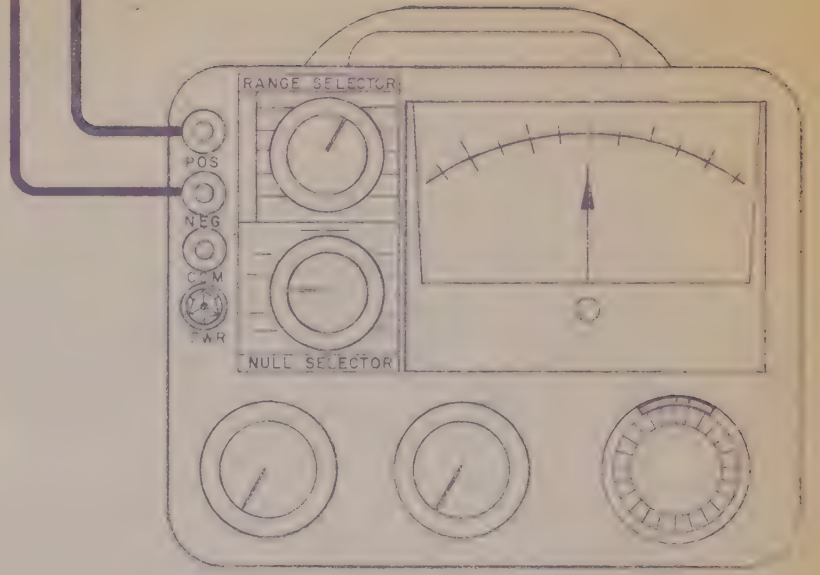
NEXT ASSEMBLY:
USED ON:

DRAWING NO. 340-018
ISSUE F

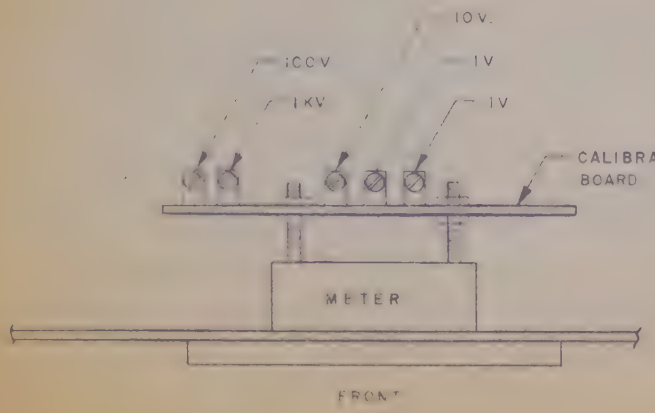


CALIBRATED STANDARD CELL

C.S.C. CALIBRATOR, MODEL C-1



VOLTMETER TO BE CALIBRATED



CALIBRATION STANDARDS CORPORATION

SCALE: NONE	APPROVED BY:	DRAWN BY
DATE 2-3-60	CHECKED BY: E. M. Z.	REVISED:

D.C. CALIBRATION SETUP

PRECISION VOLTMETER CV-1

DRAWING NUMBER 340-004 A

CALIBRATION STANDARDS CORPORATION

AC & DC Voltmeters . . .
Accuracies to ±.005% + 5 microvolts

DC Voltage Calibrators . .
Stability of ±.005%

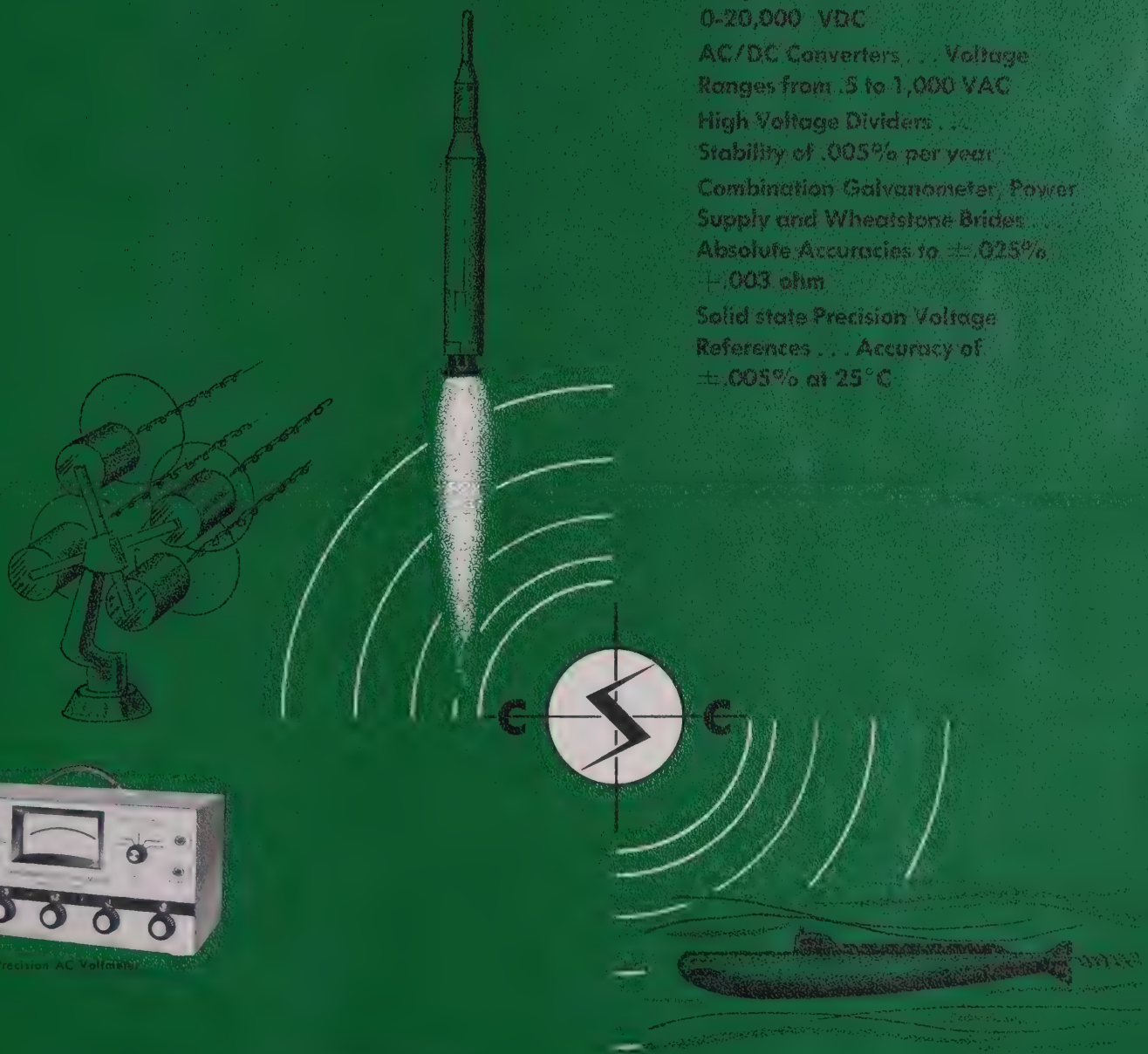
DC Power Supplies . . .
Ranges from 0-2,111 to 0-20,000 VDC

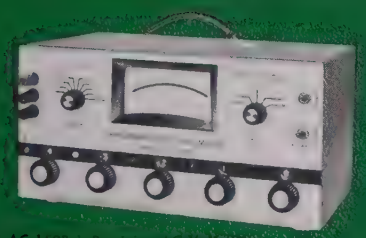
AC/DC Converters . . . Voltage Ranges from .5 to 1,000 VAC

High Voltage Dividers . . .
Stability of .005% per year

Combination Galvanometer, Power Supply and Wheatstone Brides . . .
Absolute Accuracies to ±.025% ±.003 ohm

Solid state Precision Voltage References . . . Accuracy of ±.005% at 25°C





Model AC-1508-1 Precision AC Voltmeter

Model 1208 Precision DC Power Supply

PRECISION ELECTRONIC INSTRUMENTS FOR INDUSTRY

CSC's outstanding ACCURACY and STABILITY result from...

ULTRA STABLE ZENER REFERENCE

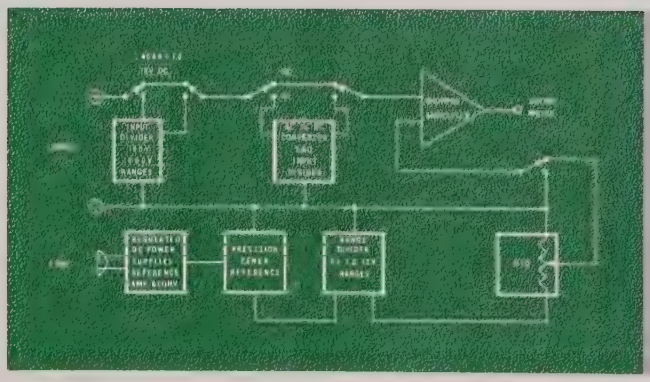
All Calibration Standards Corporation's precision voltmeters incorporate an ultra stable, temperature compensated Zener reference. The Zener reference is not adversely affected by shock, vibration, wide temperature excursions, operating position, or short circuiting. CSC, through its pioneering efforts in this field, has achieved typical yearly reference stability of ±0.001% (10 ppm) and temperature stability of ±0.0002% (2 ppm)/°C from 15°C to 40°C. References of this high caliber are utilized in the 200 series instruments.

PRECISION WIRE WOUND RESISTORS

All precision wire wound resistors are aged and tested in Calibration Standards Corporation's resistance laboratory. The resistors used in the 200 series instruments are oil filled and have long term stability better than 0.002%/year. Temperature stability is better than ±2.5 ppm/°C over a wide temperature range. These resistors are used as voltage dividers in the instruments. Therefore, the ratio stability is of prime importance and is maintained at better than 5 ppm over a year's time.

SILICON SEMICONDUCTORS

All Calibration Standards Corporation's instruments and power supplies use silicon transistors and diodes. The superior reliability and performance of these components add to the many advantages of Calibration Standards Corporation's equipment.



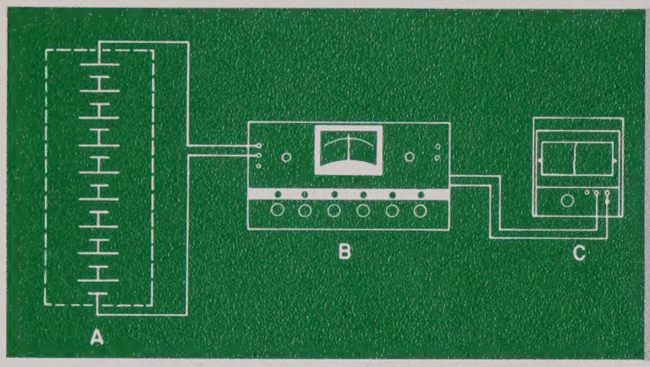
TYPICAL VOLTMETER CIRCUIT

FEATURES OF ALL CSC VOLTMETERS

Continuously Self-Calibrating (60 times per second) • Ultra-Stable Zener References (Series 200 Instruments, 0.001%/year, 0.001% for 10% line change, 2PPM/°C; Series 100 Instruments, 0.01%/year, 0.005% for 10% line change, 5PPM/°C; Series 110 Instruments, 0.005%/year, 0.005% for 10% line change, 3PPM/°C • Precision selected and aged wire-wound resistors with stability of 0.001%/year (Series 200) and 0.005%/year (Series 100) • No Zero Controls necessary • No Calibration Controls necessary • Lightweight, Compact, Portable • All Transistorized • Low Power consumption • All Accuracies stated are of reading, not full scale • Measurement Ranges of 0 to 1000 volts DC and .001 to 1000 volts AC • 6 digit readout for Series 200 Instruments, 5 digit readout for Series 100 Instruments • Most sensitive Null range is ±1 millivolt for AC and DC measurements • All instruments calibrated by Primary Standards with traceability to the Bureau of Standards • Certificates supplied upon request • All instruments available in cabinet and rack models • Recorder output to facilitate long term strip chart recording • Operation is the same for both AC and DC measurements • Ultra-Stable Kelvin-Varley Divider • Infinite Input Impedance • Differential Input •

INSIDE the CSC VOLTMETER

VOLTMETER DRIFT TEST SET UP



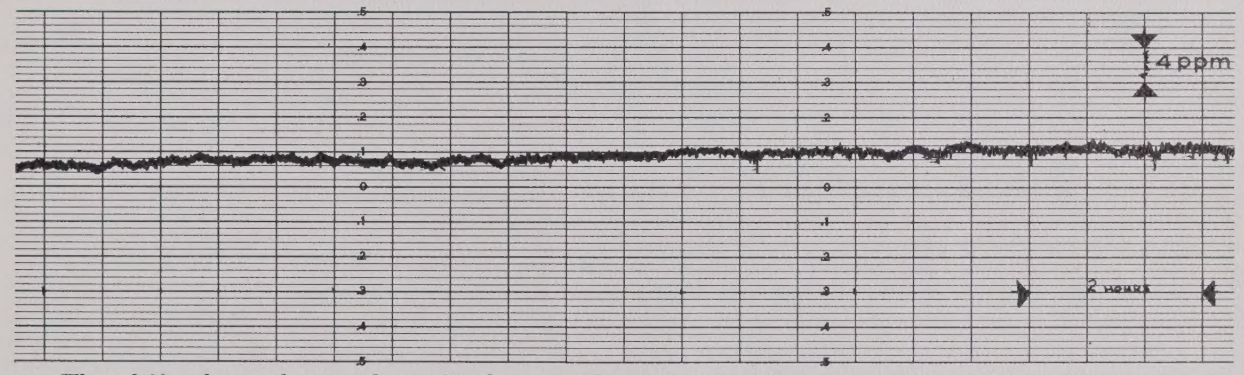
A. Bank of 12 saturated cells (9 used) in a temperature-controlled air bath S.R.I.C. Model 9152A or equivalent

B. Calibration Standards Corporation Precision DC Voltmeter Model DC-200B

C. Calibration Standards Corporation Model PSR Servo-recorder or equivalent

The set up used at CSC to measure and record total instrument drift is shown above. The results of a typical Model DC-200B Voltmeter run for 8 hours are shown below. A thirty day drift run would show only a slight increase in drift, typically better than ±.001%.

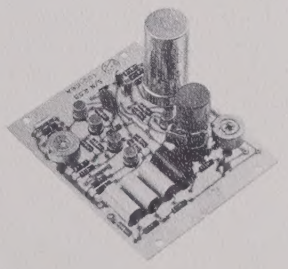
ZENER REFERENCE



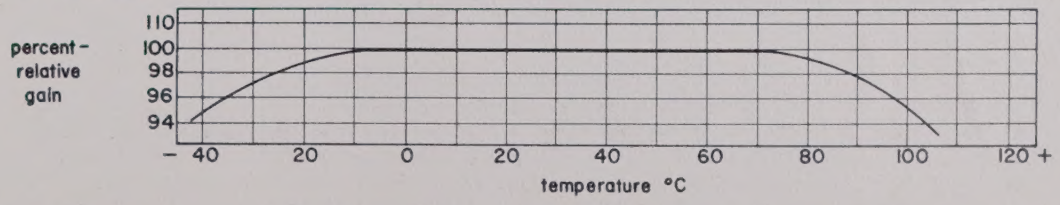
The drift chart shown above is the actual chart of a test run on a Calibration Standards Corporation Model DC-200B Voltmeter. Before beginning the 8 hour test, the Voltmeter was allowed a one hour warm-up. While the test was in progress, the ambient temperature varied from 74°F to 78°F. As the chart shows, during the entire 8 hour test, the instrument's drift was less than 2 parts per million.

NULL AMPLIFIER

Shown at right is the new Chopper Amplifier module used in all CSC "B" Series AC & DC Voltmeters. This amplifier incorporates a new high reliability, low noise chopper and silicon transistors that are responsible for the instrument's extremely stable performance even under wide temperature changes.

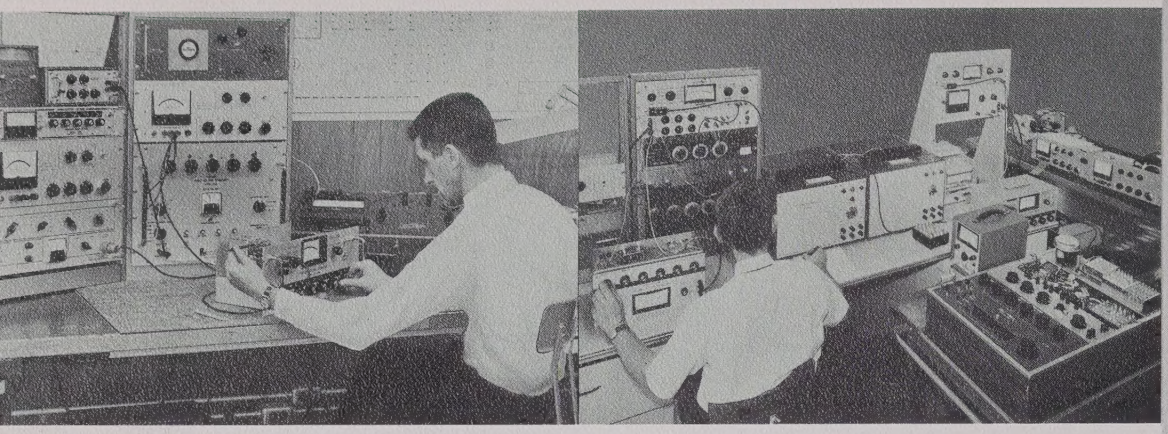


RELATIVE GAIN vs TEMPERATURE



The above graph clearly indicates the gain stability of CSC's new all silicon chopper amplifier. The gain was stable to within ½% from —10°C to +80°C.

LABORATORY AND CALIBRATION FACILITIES



TEST LABORATORY

Calibration Standards Corporation's AC Calibration Department is shown above. Each AC-DC Voltmeter and AC to DC Converter is completely calibrated twice, a pre-calibration and a final calibration. The dual calibration will show that the instrument is stable. The test equipment in all of the calibration departments is traceable to the National Bureau of Standards.

STANDARDS LABORATORY

CSC's Standards Laboratory is responsible for the periodic calibration of the Calibration Department's test equipment and working standards. In addition, special High Accuracy drift tests are run in the Standards Laboratory, using a working bank of saturated cells and precision resistor divider networks in a temperature controlled silicon oil bath. All standards in this laboratory are traceable to NBS.

CALIBRATION and LABORATORY TEST EQUIPMENT

AC INSTRUMENTS

1 ea. Thermocouple Transfer Standard, Sensitive Research Instrument Corporation, Model FLH — accuracy 0.02%.
1 ea. Precision AC Voltage Standard, Holt Model AVS-323A —.03%.
2 ea. Precision AC Voltage Standards, Holt Model AVS-321— .1% 35 cps to 10KC.
1 ea. Precision Ratio Divider, Accessory for Holt Model AVS-321.
1 ea. AC Voltage Calibrator, Elin Model VC-555—400 to 5000 cps.
2 ea. Precision AC Voltage Calibrators, Elin Model VC-555 —400 to 10,000 cps.
1 ea. Precision AC Voltage Calibrator, Elin Model VC-555— 5000 to 10,000 cps.

DC INSTRUMENTS

1 ea. Bank of 3 Saturated Standard Cells, Julie Research Laboratories Model SCO-106 Enclosure—accuracy 0.0002%.
2 ea. Banks of 12 Saturated Standard Cells, Sensitive Research Corporation, Model 9152A Enclosure — accuracy 0.0005%.
1 ea. Primary Voltage Divider, Julie Research Laboratories Model VDR-106 — accuracy of 1 ppm.
2 ea. Voltage / Ratio / Resistance / Reference Sets, Julie Research Laboratories Model VRS-105/6, Voltage Accuracy of 0.001%, 1 ppm Ratio Accuracy and Resistance — accuracy of 0.0015%.
1 ea. Binary Resistance Set, Julie Research Laboratories Model BMR-105 — accuracy 0.0015%.
1 ea. Decade Resistance Standard, Julie Research Laboratories Model BMR-105 — accuracy of 0.0015%.
1 ea. Precision Voltage Potentiometer, CSC Model PVR-1AR — accuracy 5 ppm of reading.
2 ea. Chopper Stabilized Power Supplies, 1 to 500 VDC.
1 ea. Chopper Stabilized Power Supply, 1 to 1000 VDC.
3 ea. Null Detectors, Hewlett-Packard Model 425A.

GENERAL CALIBRATION INSTRUMENTS

1 ea. 1 ohm Standard Resistor, Leeds & Northrup — 0.005% accuracy.
1 ea. 10 ohm Standard Resistor, Leeds & Northrup — 0.005% accuracy.
1 ea. 100 ohm Standard Resistor, Leeds & Northrup — 0.005% accuracy.
1 ea. 1000 ohm Standard Resistor, Leeds & Northrup — 0.005% accuracy.
1 ea. 10,000 ohm Standard Resistor, Leeds & Northrup — 0.005% accuracy.
2 ea. Amplifiers, Low Noise, Tektronix Model RM-122A.
1 ea. Oscilloscope, Tektronix Model 531A with Reamp.
3 ea. Oscilloscopes, Tektronix Model 503.
1 ea. Oscilloscope, Tektronix Model 545A.
1 ea. Oscilloscope, Tektronix Model 533A.
1 ea. Standard Resistor, Thomas 1 ohm.
1 ea. Wheatstone Bridge, Leeds & Northrup Model 4232-B.
1 ea. Direct Reading Ratio set, Calibration Standards Model DRRS-1.
1 ea. Detector, Hewlett Packard Model 425AR.
1 ea. Microvoltmeter, Astrodata Model TDA-21.
1 ea. Medistor Model A-60.
1 ea. Life Test Oven, Blue-M, Model POM400A.
1 ea. Cold Box, Missimers, 1 cu ft to —79°C.
1 ea. Megohmeter, Jahre, to 5 x 10^{16}.

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